



Aalborg Universitet

AALBORG UNIVERSITY
DENMARK

Good Examples Catalogue

“Problem Based Learning and Sustainability in Engineering and Science Education – Practice and Potential”

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GOOD EXAMPLES CATALOGUE



“Problem Based Learning and Sustainability in Engineering and Science Education – Practice and Potential”

Faculty of Engineering and Science
Aalborg University, Denmark

Good Examples Catalogue.

*Problem Based Learning and Sustainability in Engineering and Science Education
– Practice and Potential.*

April 2014

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*Front page: The word cloud is a visualisation of sustainability aspects mentions
by the 21 respondents who answered the questionnaire.*

Preface

This catalogue of good examples of integration of sustainability in the study programmes of the Faculty of Engineering and Science at Aalborg University has been prepared as part of the documentation of the project “Problem Based Learning and Sustainability in Engineering and Science Education – Practice and Potential”.

The project was initiated in February 2012 and aimed to investigate the integration of sustainability in engineering and science education at the Faculty. The Dean of the Faculty funded the project and the Centre for PBL and Sustainability, part of the UNESCO Chair in Problem Based Learning, hosted it. The project was overseen by a Steering Committee representing Faculty departments and carried out by an interdisciplinary working group.

The authors would like to acknowledge the Faculty staff members and students who contributed their time and knowledge to put together the examples in this catalogue, by filling in and submitting the questionnaire and/or by participating in personal interviews. While care has been taken to ensure that the examples are correctly described at the time of writing, any mistakes and errors in this catalogue rests solely with the authors.

AAU, November 2013

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1 Introduction

The point of departure for the study “Problem Based Learning and Sustainability in Engineering and Science Education – Practice and potential” (PBL-SUS) at the Faculty of Engineering and Science, Aalborg University (AAU), is that, like many other universities throughout Europe, AAU has signed the COPERNICUS University Charta on sustainability. This commits the university to adopt and implement the COPERNICUS Guidelines, including but not limited to, integrating sustainability into the curricula taught at the university. Thus, the study sets out to investigate to which extent this has already happened at the Faculty of Engineering and Science, AAU and how sustainability could be enhanced in the Faculty curricula.

One of the overall objectives of the study was to map existing practices and interpretations of sustainability in engineering and science programmes at the Faculty. This catalogue describes some of the good examples found in connection with fulfilling this objective.

The first section of the catalogue is this short introduction. The second section presents examples where sustainability forms the backbone of the teaching, whether in programmes, semesters, projects or courses. The third section contains examples of integration of sustainability into courses and projects that are part of programmes, which do not otherwise include sustainability to any significant degree. While the examples in sections two and three are based on information collected through interviews, including short quotes taken from questionnaires, the short stories in section four are based only on information provided in the questionnaires. The fifth section contains information about resources on sustainability.

Examples in the catalogue are identified by name and degree of the programme, semester number and, where relevant, module name. Semesters are numbered consecutively, i.e. semesters in a Master programme are numbered from 7th to 10th semester. This numbering was chosen in order to avoid confusion about the level of teaching, although some of the Master programmes do not have corresponding Bachelor programmes.

The research team recommends to the Faculty management that this catalogue should be seen as a dynamic document with ongoing and continued collection of good examples as well as with ongoing and continued collection of resources on sustainability.

It is the hope of the research team that the catalogue may inspire staff members throughout the Faculty to consider integrating sustainability aspects into their own projects and courses, in order to achieve the vision on sustainability formulated by the Dean in the August seminar 2012:

“Aalborg University will be a driving force in the creation of sustainable development, locally, nationally and internationally”

Eskild Holm Nielsen

Dean of Faculty of Engineering and Science at Aalborg University

2 “Sustainability is everything we do!”

A NUMBER OF STUDY PROGRAMMES AND SEMESTERS AT THE FACULTY ARE DESIGNED AROUND SUSTAINABILITY, ESPECIALLY ENVIRONMENTAL SUSTAINABILITY, AS THE BACKBONE OF THE PROGRAMME/SEMESTER. THIS SECTION CONTAINS EXAMPLES OF SUCH PROGRAMMES AND SEMESTERS, AS WELL AS EXAMPLES OF COURSES THAT ARE DESIGNED WITH SUSTAINABILITY AS THE MAIN CORE OF THE PARTICULAR COURSE, WHILE NOT NECESSARILY BEING A MAJOR PART OF THE OVERALL PROGRAMME.

2.1 Programmes

2.1.1 M.Sc. Urban, Energy and Environmental Planning

Programme: M.Sc. Urban, Energy and Environmental Planning, specialisation in Environmental Management and Sustainability Science (EMSS)/M.Sc. By-, Energi- og Miljøplanlægning, specialisering i Miljøledelse og bæredygtighed.

Semester: 7th -10th semester.

Interviewees/Contact persons: Henrik Riisgaard (HR) (henrik@plan.aau.dk), Associate Professor and Programme Coordinator and Arne Remmen (AR) (ar@plan.aau.dk), Professor, Department of Development and Planning, AAU-Aalborg.

Implementation of sustainability

This programme started in the 1980s at the Master's level with a focus on international technology planning. It attracted a number of students with a very broad background, including students coming from communication study programmes.

Approximately 15 years ago a Bachelor programme was started with the aim of building up student competencies from an earlier stage and also to spread content across more courses.

The international dimension of the programme is infused throughout the courses and this also attracts a number of international students.

Both AR and HR believe in the need to start as early as possible to prepare students for a career in sustainability development.

How is sustainability included?

Students for the Master programme are being selected by HR based on their background and applicants do not necessarily need to have an engineering background to be admitted. Not only grades but also previous experiences are taken into consideration when deciding who will be admitted. There is an expectation that students should have some understanding of the concept of sustainability as this is considered a prerequisite for participation in the Master programme.

Teaching may start with some guest lectures to give students a feeling of the professional field of the programme.

The project and master thesis topics often represent the students' own agendas, which allow them to shape their own profile, concerned with environmental aspects and how these are shaped by policy.

One of the key outcomes of concentrating on project work is to get students to think about, rely upon and work with their own data, rather than basing their knowledge on theoretical ideas only. The reports reveal students' individual interests and document how they apply their knowledge investigating relations between policies, socio-cultural perspectives and regulations.

Which aspects of sustainability are included?

During the first semester in the Master programme there is an 'inside focus', i.e. for example, looking into how external factors such as policies and standards influence and have an impact on a company. In the second semester, the focus is external, i.e. looking at institutional perspectives on factors, policies and governance.

In the first and second semester of the Master programme, students are typically asked to work on a problem that has either a Danish or a European perspective so students can focus on local contexts and gain access to the settings or participants they are working with. In those first two semesters, the depth at which environmental, economic and social aspects are covered in the projects can vary.

Future perspectives

Continued teaching focus will be on identifying possibilities rather than focusing on trade-offs, on creating new solutions and on getting away from earlier models.

Challenges

One of the challenges is that students bring different learning models with them. Some of them come with a discipline oriented learning background that shape their expectations and learning habits and this is a challenge that needs to be overcome in the beginning of the study. For this reason, the programme is

strongly focused on project work right from the beginning and both teachers' experience is that students very quickly get into this learning philosophy, also because some of the students are already used to the Aalborg PBL model.

Learning emphasis is placed on the students' ability to apply the course content, and this can be a challenge because this requires a cultural change in working together and applying knowledge and skills and working with information provided.

Good advice

With a diversity of students it is important as a university teacher to be 'humble and listen' because it is important to acknowledge what students bring into the teaching and learning environment.

The broad range of students, both in terms of educational background and nationality, provides a good platform for establishing a very good network across project groups, a network that is further strengthened once graduates end up in international institutions around the world.

Both AR and HR have examples of students who have progressed to other institutions but have maintained the contact with the University. The same applies to students who find work in regional local government (i.e. kommune), private companies and international organizations. As such, both teachers see their students as resource persons who contribute knowledge and skills when they join the programme and become important contacts in the future.

The different understandings students bring with them about sustainability are representative for the contexts people come from and for the local agendas of sustainability. The business community the university teachers are liaising with is recognizing this as a particular strength and are interested in the different perspectives students bring with them when they conduct their research.

2.1.2 M.Sc. Sustainable Cities

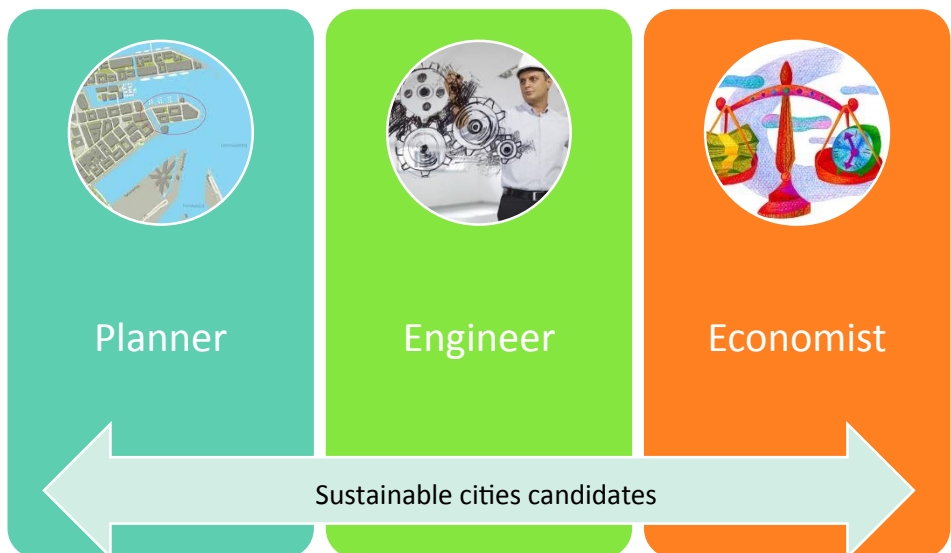
Programme: M.Sc. Sustainable Cities/M.Sc. Bæredygtig byudvikling (and 8th semester course Structures and Systems of the City/Byens strukturer og systemer).

Interviewees: Brian Vad Mathiasen, Associate Professor, David Connolly, Assistant Professor and Morten Elle, Associate Professor, Department of Development and Planning, AAU-CPH.

Contact person: Brian Vad Mathiasen (bvm@plan.aau.dk)

Implementation of sustainability

Sustainability is at the core of the Sustainable Cities programme, which started in September 2012. The main driver behind creating the new Master programme was to break with traditional sector thinking where the economist thinks of one thing, the planner of another and the engineer of a third.



The Sustainable Cities programme was developed with the aim of educating candidates who can think across sectors in order to achieve true sustainable development.

How is sustainability included?

The aim of the programme is to educate candidates who have the ability to do “tangible sustainability”, meaning that the context of sustainability is very important throughout the programme. Graduates should be able to think sustainability across sectors: water, energy, transport, resources – both from a technical viewpoint and from an institutional viewpoint. The teaching is a mix between lectures, workshops, fieldtrips and project work. The programme is an international programme – with a world view, but in order to ensure a clear understanding of sustainability, the city of Copenhagen is used as a case study throughout the lectures and projects. This is to give the students the chance to go and “pat the city” – show how sustainable practices are carried out, but also to give students a context to work with. The students have, for example, worked with the development of Nordhavn in Copenhagen – this gives them a chance to go and have a look at the area they are working with, as well as to have a look into all the planning documents the municipality has on this case.

Which aspects of sustainability are included?

The Sustainable Cities programme has a holistic approach to sustainability, which means that it never focuses on just one aspect of sustainability and most aspects are covered at some point or another. It is, however, a more technical approach to sustainability they apply – this has to do with the aim of educating candidates who can do tangible sustainability analyses.

The 8th semester course Structures and Systems of the City covers the main sectors of the city: energy, buildings, water, waste and transport but the focus is on the complexity of the systems and the synergies between them. With a course covering such a variety of different aspects of sustainability it is unavoidable that different teachers covering different elements are involved. In order to understand which role the different elements play in the course and how a particular element fits into the context of the course and the context of sustainability, it is important that each lecture starts with outlining this relationship.

Future perspectives

In 2012 approx. 20 students enrolled (50%/50% Danish/international students).

In 2013 this number has more than doubled to approx. 50 students (60%/40% Danish/international students), so even if candidates of Sustainable Cities do not have a clear cut profile, but rather a broad understanding of the complexity of the sustainable city, the future of the programme is looking good.

Challenges

When working with sustainability – either as a title programme or title course - it is important to have a clear understanding of the meaning of the concept in the given context.

Sustainability means different things to different people and to different professions. The programme has experienced students coming with an understanding of sustainability different from the understanding expressed in the programme and with expectations to what the programme would cover that were not immediately fulfilled. Some of these expectations/wishes will be included in the second run, but it has been clear from the start that the Sustainable Cities programme will educate candidates with a tangible understanding of sustainability and equipped with a set of practical tools to ensure sustainable solutions. Therefore, not all the expectations can be met through the courses: Instead, such diverging expectations must to some extent be included in the project work.

Using sustainability in the title of a programme can be challenging, but in the case of Sustainable Cities the title is a clear indication of what can be found and expected through the programme. Having “sustainable” in the title has also drawn in the many international students. If the title had been more traditional, these students might not have applied for the programme.

Teacher from Sustainable Cities:

In order to make students aware of consequences for future generations we encourage them to read about and discuss boundaries for growth and critical reflection on how things are developing. Is it, for example, fair that most money is provided for roads in Copenhagen, when there are actually more people on bikes? We don't quantify so much, but try to discuss different paradigms for development and question how current patterns of development are and how it is with the sustainability of these patterns.

We have chosen to let the students work on developing a strategic plan aimed at transforming a district into a sustainable district. The idea is not so much to assess or 'obtain' the perfect sustainability, but to engage the students in critically reflecting about how many different sustainability aspects are relevant to address in this regard.

This year we work specifically with Nordhavnen. I personally encourage the students to go into depth with certain issues of sustainability rather than trying to cope with all of them, because I believe that the critical reflection about sustainable development is the most important – and not so much trying to assess what sustainability actually is. We are aiming for a 'more' sustainable development today, but with focus on the process of development or implementation. How do you actually change current systems and practices.

Story from a student of Sustainable Cities

The main reason I chose this programme was because I was intrigued about how there could possibly be a sustainable city. I believe that sustainability is about protecting future generations and therefore not over-exploiting resources today. I don't see any of this happening in the world's cities and thus this programme interested me. I also wanted to learn how a sustainable city could be achieved in terms of politics since the politics often limit the potential for the sustainable actions to occur. The programme taught me about politics which was really great, although still a major challenge and frustration due to its nature. But there does seem to be possibilities to change some things. The programme did not show me how a city can be sustainable, however, in my definition of sustainability.

Story from a student of Sustainable Cities

Stemming from a village of 30 souls on a mountain top in the middle of a forest, I had for the longest time of my life problems to embrace our rather grey cities.

Driven by the urge to protect paradises like the one of my childhood, I multiplied the population size of my habitat by 40,000 when I moved to Munich for my study of electrical engineering. My intention was to gain a broad and solid engineering education on a top university, specializing then on power engineering and energy systems before I planned to focus on more specific renewable energy solutions.

Yet I was soon unconvinced that the narrowness of technological tweaks lives up to the size of the problems our global community faces. I asked my professor for advice and he proved an astonishing wideness by pushing me to zoom out to another level: the city scale. Offspring of this dialogue was my Bachelor's thesis, where I had the privilege to pioneer an interdisciplinary collaboration between our department and students of the Centre for Sustainable Buildings, working on solutions for the transformation of a quarter in Nuremberg.

This work turned my old aversion into an on-going love affair with cities. Searching for a Master's programme where I could pursue my new topic, I first researched German universities; but only very few Urban Planning Masters proved to have a wide enough scope to admit someone with a different background directly. When I found the programme at AAU-Cph [although not an urban planning programme], I was fascinated by the interdisciplinary and curious to experience this 'PBL'-thing. So I didn't hesitate and luckily it worked out: I became a Master's student at the programme Sustainable Cities at Aalborg University Copenhagen. It provides me with rich insights into the intertwined processes of the cityscape and how to re-shape them into the direction of sustainable development.

The interdisciplinary working environment based on the concept of problem based learning is just perfect to ensure a very deep and at the same time broad learning, coined by team spirit.

- Andreas

2.1.3 B.Sc. and M.Sc. Sustainable Design

Programmes: B.Sc. Sustainable Design and M.Sc. Sustainable Design/B.Sc. og M.Sc. Bæredygtigt Design.

Semester: 1st to 10th semester.

Interviewee/Contact person: Ulrik Jørgensen, (uljo@plan.aau.dk), Professor, Center for Design, Innovation and Sustainable Transition (DIST), Department of Development and Planning, AAU-Copenhagen.

Implementation of sustainability

The two programmes, both of which started September 2013, are elaborated versions of an educational programme that the core group of staff at DIST had been developing and conducting at DTU over the last decade. In these AAU programmes more focus has been put on sustainability and on extending the focus from just the product level to the services and systems level in which products are embedded, as their sustainability is not just a property of the individual product but is embedded in its use and the context in which it is used.

How is sustainability included?

The broad conception of sustainability takes the outset in sustainability as a societal discourse of legitimate action even if conflicting interpretations exist of what sustainability entails. At least it implies having considered the impact on environment, health, social welfare, economic survival and influence. In the programmes sustainability is introduced as a broad concept, part of an antagonistic discourse with many heterogeneous interpretations of the concept, depending upon the professional field and the methods applied within different fields. There is emphasis on revealing risks through a contextualised analysis, incl. all aspects of sustainability, and the analysis is carried out as a contextual analysis that seeks to include all aspects of sustainability at the same time as the involved uncertainties are recognised. This leads to an approach that includes experimentation and navigation within arenas that have fluid boundaries and include uncertainties.

Which aspects of sustainability are included?

A variety of approaches to and aspects of sustainability are included in the programmes, such as, among others: User needs, user involvement and co-design; user interfaces; life cycle assessments at product and at systems level; systems oriented sustainability concepts, including systems design; sustainable production processes and the use of prototypes; sustainable innovation.



Source: <http://www.studyguide.aau.dk/programmes/postgraduate/78507/>

Future perspectives

Since the educations started September 2013 the 'future' perspective is to get them up and running.

Challenges

The group designing the educational programmes have 10 years of experience with educations that emphasise design engineering and they have been inspired by a variety of international contacts. This has contributed to the fact that the accreditation was successful in the first attempt. The same experiences have also contributed to a solid core of knowledge about how the development of products, services and their systemic integration can be handled in engineering. Presently, the group is involved in research within the recent international and rapidly expanding field of 'sustainable transitions'.

2.2 Semesters

2.2.1 M.Sc. Architecture

Programme: M.Sc. Architecture/M.Sc. Arkitektur.

Semester: 8th semester.

Project/course module: Project module Sustainable Architecture/Bæredygtig arkitektur and course module Architectural Concepts in integrated Design/ Arkitekturkoncepter i integreret design.

Interviewees/Contact persons: Michael Lauring (ML) (mlau@create.aau.dk), Associate Professor, Cand. Arch. and Mary-Ann Knudstrup (MAK)

(mak@create.aau.dk), Professor, Cand. Arch., Department of Architecture, Design and Media Technology

Implementation of sustainability

Point of departure for integrating sustainability in Architecture and Design programmes was climate change concerns and it started in 1997, with a project aiming to reduce CO₂ emissions in urban areas and constructions.

In 2000 - 2002, the integrated design approach for developing sustainable architectural concepts was integrated in architecture educational programmes with focus on sustainability aspects, and bringing together technical, functional and aesthetics aspects to design low energy buildings. In 2010 MAK established a research group for Sustainable Architecture and the aim is to develop master programmes on Sustainable Architecture.

How is sustainability included?

As mentioned above, sustainability is integrated in the Master programme through a new approach, the integrated design approach. This approach not only provides an innovation in the field but also secures key elements in education, such as interdisciplinarity.

The Architectural Design Master programme embraces an integrated design approach which integrates technical, functional and aesthetics aspects of design.

This approach also makes good sense when aiming to integrate sustainability. It furthermore creates an education where students are able to address societies' technical and societal changes (e.g. fast technological advances and need for sustainable development).

Interdisciplinarity comes into the programme as a result of the integrated design approach. Students have a high degree of flexibility and do not face barriers when working in interdisciplinary environments. Interdisciplinarity is part of the integrated approach to design, which also extends to the bachelor level so students start to get prepared for master education.

The teaching styles are mainly lectures, workshops, excursions and study tours. Study tours aim to put students in contact with very sustainable buildings and constructions, like for example zero energy building in Southern England, or re-use of power plant. For these study tours students have to choose one of the projects to be visited and investigate it in terms of historical background, sustainability and cultural aspects that will be observed *in situ* afterwards. Some of these aspects may be integrated in their semester projects later on.

Students work within a frame provided by the staff, like for example requirements for design, but they also have freedom to explore their creativity and sustainability aspects that they want to look into. Sustainability aspects are crucial for the semester and are part of the final assessment. The students have to design and calculate a zero-energy building.

According to ML students have a very positive attitude towards the programme although this depends upon the type of students (some relate themselves more with artistic dimensions while others relate more with technical and functional components of architecture), but they are all aware of the competencies the programme provides and their needs for such competencies when they as candidates must face the real world.

Which aspects of sustainability are included?

The main sustainability aspects addressed in the programme and pointed to by the interviewees are:

- Social aspects are very much linked with architectural practice - designing houses that provide good and healthy living conditions for people;
- Environmental aspects like, for example: types of materials, CO₂ emissions, energy consumption etc. According to ML, looking into the environmental aspects has some novelty in architectural education. Also indoor climate and low energy buildings are central subjects for a sustainable and integrated approach to architectural design.
- Indirect economic impacts are handled as a consequence of the contexts in which students have to design buildings (e.g. students are educated to be reflective and realistic, e.g. when they are asked to design social housing that people can afford and with low energy requirements).

Future perspectives

In the future interviewees expect to be able to launch a full master programme on sustainable architecture instead of only a semester.

Challenges

From 2000-2005, MAK was alone, working to establish a community of practice and introducing the integrated design approach and sustainable architecture (both in research and education). Main challenges are related with difficulties of financial support from government.

For 5 or 6 years it was very difficult to integrate sustainability aspects and integrated design approach to the programme due to the non-compatible expertise of staff employed (traditional engineers or traditional architects). However, building up a community in integrated design approach and sustainable architecture has been very important to overcome these early challenges, as has establishing a group where sustainability in architecture brings people together.

Good advice

The integration of integrated design approach in the programmes was done step by step and has in recent years had its focus on low energy buildings.

ML thinks there is always a need for adjustment on semesters when regarding integrating sustainability in the Architectural Design Master programme. Some

adjustments are more structural, like, for example, organizing the curriculum in the 5 ECTS courses and 15 ECTS project model, as it happened in 2010. Others are related to increased energy saving demands in building legislations, for example the technical aspects. One of the main arguments ML points out is that Danish architectural tradition has mainly focused on functional and aesthetics aspects. However, technological advances are quite fast in society, thus the Architecture and Design-education in Aalborg with an integrated approach combining architecture and techniques will prepare students better for professional practice.



Top: Workshop in environmental architecture at AAU. Below: Exhibition from architecture graduate projects from AAU. Source: <http://architecturaldesigner.dk/the-programme/>

8th semester M.Sc. Architecture

The course Zero energy buildings focuses on how Net Zero Energy Buildings—Active Houses can be designed and build, These houses will over approx. 40 years produce the same amount of renewable energy that it took in fossil energy to construct them. And after the 40 years the houses will continue to produce energy.

The course focuses on the environmental aspects of sustainability, covering environment, materials, energy, water, but also economic factors like product responsibility and indirect economic impact. The course has a long term outlook- working with long-lasting buildings, but also creating awareness of which consequences doing nothing will have.

8th semester M.Sc. Architecture

Teacher from M.Sc. Architecture, 8th semester: We set up demands for sustainable performance of projects like; energy use, indoor environment and everyday life in the buildings. The teaching contains plenty of learning about strategies, policies, case studies, workshops etc. about sustainable architecture – environmentally, socially and a little economically.

8th semester M.Sc. Architecture

Teacher from M.Sc. Architecture, 8th semester: The built environment accounts for 40% of total energy used. Architecture, just by form, material and organization can save 70% of that part of the total energy budget.

2.3 Courses

2.3.1 Policy, Planning and Governance

Danish title: Politik, planlægning og governance.

Programme: M.Sc. in Urban, Energy and Environmental Planning/M.Sc. By-, energi- og miljøplanlægning.

Semester: 8th semester course.

Interviewee/Contact person: Ole Busck (OB) (oleb@plan.aau.dk), Associate Professor, Department of Development and Planning, AAU-Aalborg.

Implementation of sustainability

OB has a professional background in environmental management in Denmark but also in Central American countries, with experiences in working with NGO's.

OB is aware that society is transitioning and that global issues such as climate-change have widened the debates beyond environmental factors to draw attention to social responsibility.

How is sustainability included?

Setting the teaching scene through concrete contexts, drawing on cases both from abroad and from Denmark, is an important teaching strategy within the department and the programme and it is also part of OB's teaching strategy.

A number of OB's students study problems in contexts outside of Denmark, for instance in Ghana and many students are coming from developing countries. A common denominator amongst the students who progress to Master level and PhD is their interest and focus on social aspects.

Which aspects of sustainability are included?

A strong emphasis in this course is on the often-underemphasised social perspectives when it comes to teaching sustainability aspects. In his teaching OB draws attention to global aspects of sustainability, with emphasis on politics and social aspects and the effects of the resource flow from poor countries to rich countries.

OB tries to pay attention to the contextual scenarios, including regulative, normative and cultural/cognitive institutional frameworks and draws attention to technology not being conceived as the solver of all sustainability issues but sometimes also being the reason why societal issues arise.

Challenges

In order to address the challenge to encourage students to be more critical OB emphasizes bringing in his personal experiences, and practical examples together with theory. He is aware that many students say that sustainable development is very important but he tries to emphasize that they need to adopt critical perspectives and analytical methods as part of their competencies. This may include what it means to think about strategies of de-materialisation or issues of sufficiency as opposed to economic growth.



Source: www.studieguide.aau.dk/uddannelser/bachelor/30332/

2.3.2 Holistic Design for Sustainability: Systems, Processes and Products

Danish title: Holistisk design for bæredygtighed: Systemer, processer og produkter.

Programme: M.Sc. Environmental and Resource Management/M.Sc. Miljø og ressource management, a programme offered jointly by Southern Danish University (SDU) and AAU-Esbjerg, and administered by SDU.

Semester: 8th semester course.

Interviewee: Erik Hagelskjær Lauridsen (EHL), Senior Researcher, Centre for Design, Innovation and Sustainable Transition (DIST), Department of Development and Planning, AAU-Copenhagen.

Contact person: Niels Vestergaard nv@sam.sdu.dk

Implementation of sustainability

Shortly after having joined AAU in Autumn 2012 EHL was approached by a colleague from AAU-Esbjerg asking him whether he would be willing to conduct ½ of the above mentioned course during Spring 2013 and he accepted. Following this he prepared a list of relevant topics to be taught and this list was approved by the course responsible person in AAU-Esbjerg. Due to the distance between AAU-Copenhagen and AAU-Esbjerg the suggested topics were lumped together into a series of 3 lectures, lasting up to 6 hours. There was no time for study visits or guest lectures.

How is sustainability included?

In his part of the course EHL introduced a sociological sustainability concept – a broad concept that sees sustainability as contextual and determined partly by the product, partly by the use of the product and thus by the user of the product. To make students aware of sustainability consequences for future generations he introduced the Factor 10 argument that sustainable products have to be not just 10% improved with respect to environmental impact but rather have an impact which is only 1/10 of the present. Such radical improvements will require not only better products, but also entirely new ways of consuming with products and product-systems.

Which aspects of sustainability are included?

Aspects included in EHL's part of the course were, among others: Environment, products and services, product responsibility and economic performance. In the other half of the course, conducted by an AAU-Esbjerg colleague, Life Cycle Assessment (LCA) was the essential element of course contents. Students were doing a mini project as part of the course but hardly any of the students consulted EHL in connection with this project work which in all cases was focused on LCAs.

Challenges

One of the major challenges in the course was that the two different conceptions of sustainability: Sustainability as (mainly) described through LCA where sustainability is seen as an immanent feature of a given product and the sociological concept where sustainability is more contextualised and also depends upon users and usage, did not co-exist easily and students in the course pointed out this dilemma. In the project work related with the course the focus was on LCA and in the exam the focus was similarly on LCA where EHL tried to include a discussion of contextualisation of LCA results in the project.

The course assessment was rather positive and students were generally positive about the course, which was seen as both relevant and interesting. Several students, however, also noted that the two parts of the course were conflicting, a conflict which was never reconciled, and which made it somewhat difficult for the students to identify the key perspective (ontology) of the course.



SDU and AAU Esbjerg. Source: <http://maps.google.dk>

2.3.3 Green ICT: Sustainable Business Development

Danish Title : Grøn IKT – Bæredygtig forretningsudvikling.

Programme: M.Sc. Innovative Communication Technologies and Entrepreneurship (ICTE)/M.Sc. Innovativ kommunikationsteknologi og entreprenørskab.

Semester: 9th semester, Elective course.

Interviewee/Contact person: Iwona Windekilde (IW) (iwona@cmi.aau.dk) Assistant Professor, Centre for Communication, Media and Information Technology (CMI), Department of Electronic Systems, AAU Copenhagen.

Implementation of sustainability

The course was designed as part of IW's shift from a Post-Doc research position to become an Assistant Professor with teaching obligations in CMI. She was given a choice of two areas of teaching: Social networking or Sustainability and green ICT and because she has previously, in Poland, worked with green ICT and has a personal interest in sustainability this became the choice – a choice which was backed by the Head of CMI, Knud Erik Skouby (KES) and colleagues within CMI. Thus, course planning was initiated and a conference called "Green ICT: Is ICT part of the problem or the solution?" was planned and implemented. Prof. Dr. Lorenz Hilty, University of Zurich, participated in the conference and has since shared his research work with IW and also played an important role as IW's mentor and he provided support in the course development process, while KES has provided inspiration and has been very helpful in establishing contacts to resource persons within the ICT environment. Thus, there have been no problems or difficulties in terms of designing and implementing the course and integrating it into the study programme. So far the course has been conducted twice, Fall 2011 and Fall 2012.

How is sustainability included?

When conducting the course IW emphasizes the integration of 'real life' experiences, both in the form of study tours and invited guest lecturers. Thus, a study visit to an electrical vehicle operator, including a ride in an electric vehicle, is part of the course and students have the possibility to ask questions to this operator. A director from Siemens (a participant in UN Global Compact) is one of

the persons invited to be a guest lecturer, explaining to students the value of integrating a green perspective into ICT from the outset of the design process. Another guest lecturer comes from a small recently established company called 'Blue Town' that designs solar energy based communication solutions for rural areas. IW gets support from KES to identify relevant guest lecturers for the course, because good cases are important for the real life perspective in the course. Students are asked to prepare case studies in connection with the course. Assessment of the course is based on a mini project and a written synopsis that students prepare individually and submit to course lecturer and internal examiner 1 – 2 weeks before an oral exam is conducted, where the synopsis is the basis for the discussion.

The number of students choosing the course has been approximately 1/3 of the total number of students in the programme (6 out of 20 – 25). Student evaluations of the course have been very good and IW mentions a couple of success stories about students who chose sustainability and green ICT as topics for their Master projects, inspired by the course.

Concerning supervision of mini projects IW is the only supervisor for students' groups doing projects on business development, while she is a co-supervisor for groups working within the application area and wanting to integrate sustainability into their project. Thus, there is close cooperation with colleagues within CMI concerning sustainability.

Which aspects of sustainability are included?

In the course, IW applies the sustainability definition found in the Brundtland report and in the first overall lecture, she includes all three aspects of sustainability: Environmental, social and economic sustainability; thus, a global perspective is integrated into the course and she says that the weighting of the three aspects depends upon the current situation of a country – in some countries the social or the environmental aspects are weighted higher, while in financial crisis situations and in poor countries the economic aspects become more dominant.

As indicated in the title of the above mentioned conference the perspective in the course is that ICT is both part of the problem in the sense that producing and using ICT emits CO₂ and thus contributes to global climate problems but ICT can also be part of the solution, e.g. by controlling energy consumption etc. Such

tools as life cycle assessment and cradle-to-grave analysis are parts of the course.

In the ICTE programme there are three strands of study: Application, Business and Security and if students want to learn about issues of social sustainability in connection with security IW invites some colleague or other expert who can lecture on that because her own field of specialization within sustainability lies mainly in the economic area – she is an economist by education.

Future perspectives

Presently, IW is the only teacher in the course but there is a joint interest among colleagues in the multidisciplinary group in CMI for integration of sustainability aspects in the teaching. Conc. reflections on whether to make the course a compulsory course for all students IW says that she does not know the process for doing this and that she thinks the strategy of the university is to do this in steps where the elective is the first step, and further steps will be based upon students' interest in the course.

Concerning the future IW mentions that new opportunities are opening up in connection with new research projects on green ICT that CMI is in the process of launching. She mentions a project on Green Bus Lines in Copenhagen and another project about Intelligent Buildings to the Danish Defence Forces. When these projects are launched the number of students in the course will also grow. In connection with the upcoming research projects possibilities of collaboration

with other departments and other research groups within AAU will be explored, such as the Traffic group, Department of development and planning and the DIST group from the same department in AAU Copenhagen.



Presentation by Iwona Windekilde, August 2012

2.3.4 Ecological Economics

Danish title: Økologisk økonomi

Interviewee/Contact person: Inge Røpke (IR) (ir@plan.aau.dk), Professor MSO, Centre for Design, Innovation and Sustainable Transition (DIST), Department of Development and Planning, AAU-Copenhagen.

The course is still in the planning stage – this example illustrates visions for a future course.

Implementation of sustainability

This course is still in the planning process but is included here due to its relevance to the broad concept of sustainability, especially the economic sphere of sustainability.

IR has for many years been working with ecological economics, both the broad development of the field and specific issues related to environmental perspectives on growth, trade, technological change, and consumption. At DTU she conducted a course called “Environment and economics” which was originally established as an optional course but the course was so popular with students that it soon became a compulsory course for students in the Master in Environmental Engineering. She would like to offer a similar course at AAU-Copenhagen.

How is sustainability included?

The fundamental idea of ecological economics (EE) is to look at the economy in biophysical terms and describe the economy as an organism, a kind of ‘body’ that is kept alive by flows of matter and energy. The important question is how large this organism is and how large it can grow, i.e. how much space it takes up in the biosphere that human beings are dependent upon – the bigger the ‘body’ the greater the risk of undermining the conditions that support human life. EE offers means of measuring this ‘body’ and its flows, e.g. via analysis of flows of materials, energy accounts, biomass measures, ecological footprint etc.

Since this perspective of the economy as an organism leads to the necessity of accepting that there are limits to (economic) growth, ethical considerations about the fair and equal (re)distribution of resources both at local and at global level, are included. Thus, rather than simply suggesting that poverty alleviation

can happen through (unlimited) economic growth, alternative ways of creating a fair distribution of resources are sought. Where traditional economics offers cost-benefit analysis as an instrument for decision-making, EE is critical of cost-benefit analysis and offers alternative ways of decision-making, such as, e.g. participatory methods.

Which aspects of sustainability are included?

The course would include, among other things, such aspects as the concept of planetary boundaries, ecosystem services and resilience, human society as a metabolic organism embedded in nature, economic background of environmental problems, drivers behind consumption growth, the environmental impacts of consumption, relations between trade, globalisation and the environment, critical perspectives on cost-benefit analysis and possible alternatives.

Challenges

The main challenge for offering the course is according to IR the rigidity of the educational system at AAU that presents only limited possibilities for offering elective courses.

3 “Sustainability forms part of what we do”

IN MANY STUDY PROGRAMMES IN THE FACULTY SUSTAINABILITY IS NOT AT ALL VISIBLE IN THE PROGRAMME CURRICULA AND YET THERE ARE ELEMENTS OF SUSTAINABILITY IN SOME OF THESE PROGRAMMES. THIS SECTION CONTAINS EXAMPLES OF SUCH ‘POCKETS OF SUSTAINABILITY’ FROM ALL THE THREE SCHOOLS WITHIN THE FACULTY.

3.1 Courses

3.1.1 People and Nature

Danish title: Menneske og natur.

Programme: Joint course: B.Sc. Urban-, Energy- and Environmental Planning and B.Sc. Geography/B.Sc. By-, energy- og miljøplanlægning og B.Sc. Geografi.

Semester: 5th semester course.

Interviewee/Contact person: Eva Ritter (er@plan.aau.dk) Associate Professor, Department of Planning.

Implementation of sustainability

The course is a result of the new school structure with 5 ECTS courses that was introduced a couple of years back. This course is one of the (few) successes of joining two existing 2.5 ECTS courses to one 5 ECTS course. The People and Nature course is made up from a former SE-course; Human Ecology and a former PE-course; Concepts and Perceptions of Nature.

The new structure has meant that there is much more room for and focus on sustainability! It is a bigger course now and the focus has shifted slightly in the process of joining the two courses.

How is sustainability included?

The course has mainly been based on classic lectures, but in 2012, a fieldtrip was added with great success. This fieldtrip gave the students an insight into the differences between theory and practice, as well as an insight into how municipalities, among others, work. The problem with adding this fieldtrip was that the planning and the trip itself had to be paid from the existing hours included in the course and this might not be possible to do in the following years. However, the fieldtrip got a very positive feedback from the students, and it would be a real shame to have to leave it out.

Having to 'pay' for the fieldtrip with the existing hours for the course also meant that the content of the field trip had to be part of the curriculum, which posed

some challenges regarding mandatory or optional participation of the students. Fortunately, all students were able to participate in the field trip in 2012.

Which aspects of sustainability are included?

Sustainability is mostly focused on the environmental sustainability – focus is on humans' influence on nature/environment. In order to place the course in the context of sustainability and define the concept of sustainability, the students had an introductory lecture on sustainability - its meaning, origin and elements of it.

As the course went from being two courses for geography students to being a single course for geography- and urban-, energy- and environmental planning students the content of the course also shifted slightly to include some lectures on energy.

Several teachers were involved in the course and they were not told to focus on sustainability, but as the students had an introduction to sustainability in the beginning and as the focus of the course was on the complex relationship between humans and nature, it can be argued that sustainability could be found throughout the course, although not necessarily explicitly.

The course covers themes like sustainable development, landscape management, nature conservation, energy consumption as well as biodiversity and value.

The examination of the course was a 6 hour written essay examination with two main questions. One of these questions was regarding sustainable development and environmental impact. The fact that 50 % of the exam is explicitly concerned with sustainability shows that the course lecturers are taking sustainability seriously.

During the examination process, it was experienced that examining sustainability is difficult. Even after the lectures on sustainability, the concept was still open to interpretation. Writing the exam questions was a balancing act between being explicit to ensure the students understood what was asked, but not being so explicit that the question would be answered within the question itself.

Future perspectives

There are no plans to implement any changes – and the course is still running. The hope is to continue the fieldtrip, but it depends on finances and whether a volunteer can be called in to run the day itself.



Geographers in the field. Source: Kirsten Krogh Hansen

3.1.2 Renewable Energy Structures: Wind Turbines and Wave Energy Devices

Danish title: Konstruktioner til vedvarende energi: vindmøller og bølgeenergi-anlæg.

Programme: M.Sc. Structural and Civil Engineering/M.Sc. Bygge- og anlægskonstruktion.

Semester: 9th semester course.

Interviewee/Contact person: Lucia Margheritini (LM) (lm@civil.aau.dk), Associate Professor, Department of Civil Engineering.

Implementation of sustainability

LM lectures several sessions in the course mentioned above, and integrates some concepts of sustainability in its introduction. According to LM there are plenty of opportunities to integrate sustainability in civil engineering education; and such opportunities should be exploited early on in the educational programmes.

How is sustainability included?

Lectures in the 9th semester require a more in-depth preparation on technical aspects (including laboratory related work) but also an introduction of energy and renewable energy concepts (what it is, why it is important, what are the implications, etc.). The course is mainly characterised as technical, for example, a student works with wave energy machinery in laboratories, but does have some room for analysing the above questions.

Some of the sustainability aspects LM brings to the lectures are related with politics and economics, partly because the construction of wave energy machinery is closely linked with aspects of economy, business models and public participation. However, environmental sustainability is weighted higher than the other aspects of sustainability.

Another social aspect given some emphasis is public participation, which may determine the success or failure of an engineering project. For example, in one of the two cases given in the lecture, the local community opposed the installation of harbour structures due to the installation noise (students experience the

noise through a video). Other examples of teaching strategies are pictures and pieces of art that illustrate the sustainability and renewable wave energy concepts.

According to LM it is not common for students to bring sustainability into their projects, or to take a deeper interest in such topic, but there are some exceptions. It mainly depends on students' attitude, whether they are greener than others, whether they see employment opportunities. With few exceptions, in cases where students brought sustainability to their projects it is by their own initiative.

Which aspects of sustainability are included?

Introduction of energy and renewable energy but also some economic and social aspects as mentioned above.

Future perspectives

One of LM's future perspectives for this course would be to bring other colleagues and professors to talk about, for example, planning, grid connections and power production efficiency, etc., which would provide a more holistic view on course subjects and content.

Challenges

One of the main challenges in integrating sustainability is related to the interdisciplinary communication, forcing one to communicate outside of one's own area of expertise. However, LM says that if a person searches enough one would eventually find people interested in collaboration.

Another challenge is related to students' profiles. They have an engineering profile – they want to do calculations and constructions. Normally students see the introduction of sustainability aspects as a boring part of the course; however, the use of real examples and creative teaching activities may overcome such challenge.

3.1.3 Inorganic Chemistry II

Danish title: Uorganisk kemi II.

Programme: B.Sc Chemistry/B.Sc. Kemi.

Semester: 5th semester course.

Interviewee/Contact person: Vittorio Boffa (VB) (vb@bio.aau.dk), Assistant Professor, Department of Biotechnology, Chemistry and Environmental Engineering.

Drivers for implementing sustainability

The nature of the content in inorganic chemistry can be abstract, for example, it includes teaching concepts such as the properties of the groups of elements in the periodic table. Applying contextualised examples makes the learning experience more meaningful and helps develop student competencies.

How is sustainability included?

In his teaching VB is working with relatively small groups of students. His lecture series starts by focusing on sustainable practices followed up by an exercise where students have to calculate wastage by focusing on atom economy.

VB believes that this approach is especially useful for those students who will later work in or with industry and who need to be familiar with sustainability concepts, in particular when dealing with chemical synthesis and materials development.

The focus in his teaching in respect to sustainability is on environmental and economic aspects while there is lesser focus on social aspects. The students typically work on a project where they receive plenty of feedback by VB on their investigations. One aspect is also that VB tries to get students to 'look back' and reflect on how their previous work may be affected by the new knowledge and concepts they have gained.

Which aspects of sustainability are included?

Environmental and economic aspects

Future perspectives

The nature of the subject chemistry means that it has to fight the ‘bad reputation’ of being perceived as abstract with a narrow focus. However, changes in society, science and teaching models mean that things have and are continuously changing including in chemistry. Overall, VB believes that a focus on context is an appealing way to teach, learn and apply inorganic chemistry and he sees potential to attract more students while increasing industry interest for students who go through this education.

Challenges

Challenges include how to adopt a problem based teaching approach in inorganic chemistry where students need much teacher support. It includes also how to overcome a shortage of textbooks that cover inorganic chemistry and sustainability aspects, especially when the teaching focus demands applying theoretical knowledge to experimental investigations. VB overcomes this by identifying research articles and by bringing in his own research examples.

Good advice

Research projects that focus on sustainable practices can be more easily funded and this can also create new teaching and learning opportunities. By focusing on applied and contextual examples, future chemists are also made aware of issues concerning usage and wastage of materials and resources, which is less of a problem in lab environments, but is often among the key issues in industry.



Source: www.studieguide.aau.dk/uddannelser/bachelor/32619/

3.2 Projects and project themes

3.2.1 Energy Reduction in Sea Water Reverse Osmosis Plants

Danish title: Energigenvinding I SWRO anlæg.

Programme: M.Sc. Mechanical Design/M.Sc. Maskonstruktion.

Semester: 9th-10th semester project.

Interviewee/Contact person: Anders Schmidt Kristensen (ASK) (ask@civil.aau.dk), Associate Professor, Campus Director, Department of Civil Engineering, AAU-Esbjerg.

Implementation of sustainability

The Master thesis project deals with the design and analysis of energy consumption of a Sea Water Reverse Osmosis (SWRO) system, better known as a water maker that makes freshwater out of saltwater. The project is carried out in collaboration with Danfoss and was initiated based on a proposal from a former student of ASK now working with Danfoss. The project addresses the 'grand challenges' mentioned in the Faculty strategy and includes analysis of the value adding process of optimizing energy consumption.

ASK says that it is an exciting project and that sustainability is an important aspect for a company like Danfoss. It is a sales argument if they can deliver more energy efficient products than the competitors. Asked whether this should lead to integration of sustainability in educations more generally, the answer is that in the education, the basic professional tools are more important – the better students learn to use the basic tools, the better they will be able to make analysis of products for sustainability. Thus, they get the tools via the education and then integrate sustainability afterwards. If the order of things were the other way around, too much focus on sustainability might lead to less satisfactory ability to use the basic tools.

How is sustainability included?

In this project the sustainability concept is mainly perceived as a question about optimising the energy consumption in the SWRO process and demonstrating to students the value adding of such a design approach.

Which aspects of sustainability are included?

The main sustainability aspects are energy and water but also security, product responsibility, product and service labelling, market presence and indirect economic impacts are included in the project. In the BSc programme Mechanical Design ASK also introduces aspects of sustainability, e.g. in the form of life cycle assessment, product market cycle and product life cycle analysis, from 1st semester onward. Such aspects are integrated in the course Basic Mechanical Construction and also in the projects, but are not visible in the curricula, e.g. in the form of a learning outcome.



Source: www.studyguide.aau.dk/programmes/postgraduate/54209/

Comments from one of the Master Thesis students:

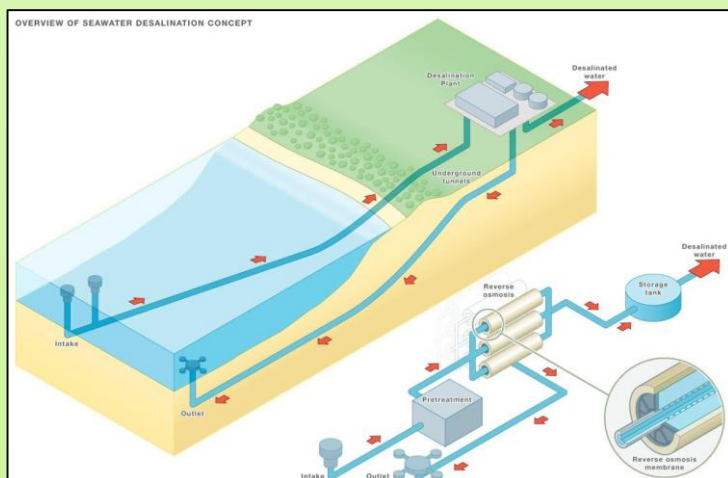
Our choice of the specific project was based on the following criteria:

- Working in collaboration with a major industrial company, thus a more practically oriented as well as research oriented thesis. Furthermore we might gain insight into the work within the industry.
- The project description implicated the opportunity to work on interesting subjects that, in contradiction to other project options, have not prior been investigated.

In general the project was chosen because of the possible research and investigation options, and also due to the curiosity on working with the concrete topic.

Aspects of sustainability in the project were as follows: Investigating the technology that generally enables purification of seawater to potable water; analysing components that allow purification of seawater with highly reduced energy consumption.

Included below is an illustration from the project showing the essence of the investigated systems.



3.2.2 Sustainable Lifestyle

Danish title: Bæredygtig livsstil.

Programme: B.Sc. Medialogy/B.Sc. Medialogi.

Semester: 2nd semester project theme.

Interviewees/Contact persons: Hendrik Knoche (HK) (hk@create.aau.dk), Assistant Professor, Department of Architecture, Design and Media Technology & Jette Egelund Holgaard (JH) (je@plan.aau.dk), Associate Professor, Department of Development and Planning, AAU-Aalborg.

Implementation of sustainability

Media technology is an interdisciplinary field integrating design, communication and computer science, e.g. addressing Human Computer Interaction. Media technologists are concerned with how a particular message can be mediated and adapted to the target group by use of electronic means. Technically, they work with animations, computer games, applications, sound and films, graphics and interactive environments. Media technology can thereby be seen as an informative mean to increase the awareness of sustainability, to push for sustainably sound attitudes, behaviours and practices and provide systems to monitor impacts of doing so.

How is sustainability included?

The approach to integrating sustainability in the programme of medialogy has been to introduce an area of sustainability as the semester theme, e.g. climate change in 2009 and sustainable lifestyles in 2013 (see box 1). Furthermore, the students were introduced to the concept of sustainability in the course “Problem Based Learning and Science, Technology and Society” in the first semester – although the focus on sustainability was limited.

Two status seminars were provided during the semester, one challenging the students to come up with at least three ideas on how to address sustainability by use of ICT and one reporting on the problem analysis and presenting the problem formulation. At these seminars, the students became acquainted with different ways of using media technology to foster more sustainable lifestyles by attending presentations from peers.

Which aspects of sustainability are included?

Although the main focus were on rather traditional approaches to sustainability, such as reducing energy consumption, also alternative approaches were results of this overall framing of projects to address sustainability. Four groups stressed environmental aspects: Visualizing energy consumption (2 gr), educating children for environmental protection (1 gr), and getting people to use CO₂ neutral means of transportation (1 gr). Four groups stressed resource/natural aspects: Getting people to use the waste containers in public places (2 gr), save water in the shower (1 gr), and increase the market shares of organic food (1 gr). Finally, four groups actually stressed social aspects of sustainability: Children and overweight (1 gr), mental health to prevent depression (2 gr) and sustaining cultures (1 gr). The three mentioned projects are rather untraditional in the discourse of sustainability, but the students argued convincingly for the link.

Future perspectives

The introduction of an open-ended thematic frame encouraged students to broaden their perspective on sustainability, stressing economic, environmental as well as social concerns. But students approached this broad theme with very limited subject knowledge, making it complex for them to address sustainability. Some seem to fall back on a common sense understanding of sustainability; others choose rather untraditional and rather interesting approaches. Whereas the open-ended start seemed to be enough to kick-start creative thinking, on-going ad-hoc seminars would have been supportive in the problem analysis phase.

Challenges – how are they overcome?

HK recognizes the relevance of integrating sustainability in education; however, several challenges related to the integration have to be overcome, as for example:

- Creating a shared understanding of what sustainability means for students as well as facilitators;
- That the complex area of sustainability can be hard to integrate at a time where the students are in a transition phase from high school to university, as they also have to focus on getting process competences in relation to group work, problem analysis and formulation, etc.

- Too many degrees of freedom do not work well together with a broad theme on sustainability. A solution could be to limit the theme in itself, but also limitations can be set on the choice of target groups, the modalities for mediation etc.
- To some extent, students bring out-dated common-sense sustainability concepts into their projects – therefore there is a need for discussion and clarification.
- Students sometimes have some pre-conceived idea of what they want to work with and afterwards they make a link with sustainability without much reflection.

Finally, all sustainability themes represent an opposite trend to the IT professional approach (exponential growth and short life-span of data products) so it is a challenge both for students and educators to marry both - how to teach sustainability with tools that at are the same time part of the problem?

Comment from at teacher

Teacher from B.Sc. Medialogy, 2nd semester: I try to make students aware of sustainability by demonstrations and examples of energy harvesting by technological means, by examples of how this can be made in the most simple way, by using different kinds of sensors for energy, water flow etc., both in courses and in projects.

I also include demonstrations and examples of how to use electro-chemical sensors to measure the presence of substances in the environment.

Good advice

HK recommends narrowing down, for example, the sustainability theme to something more concrete for students, or in other ways limiting the degree of freedom to something manageable. Also it was recommended to guide students in the learning process by a step by step approach, like for example introducing a concept (e.g. in sustainability), work with it, involve students in small exercises and tasks, and when everyone is at the same level move on to the next level. At higher levels of education it may be possible to work with broader concepts and themes.

BOX 1: Description of semester theme on sustainable lifestyle

Unless we change our current lifestyle patterns it will not be possible to keep the high levels of quality of life currently enjoyed. According to Mont (2007) sustainable lifestyles are patterns of action and consumption, used by people to affiliate and differentiate themselves from others, which: meet basic needs, provide a better quality of life, minimise the use of natural resources and emissions of waste and pollutants over the lifecycle, and do not jeopardise the needs of future generations.

As sustainable development is seen as one of the “grand challenges” of our time, several top-down attempts have been made from governmental institutions to foster more sustainable lifestyles, especially in the industrialized parts of the world where the ecological footprint cannot easily be overlooked. One initiative is the SPREAD project representing a European social platform for Sustainable Lifestyles 2050. In this project, working groups including researchers, business partners and non-governmental organisations are working together to provide sustainable transport, housing, consumption patterns and infrastructures.

But it is not enough to create policies, strategies and plans for more sustainable lifestyles; citizens need to have access, will and competences to act accordingly to bring about the required changes in a bottom-up fashion. As stressed by Van der Ryn & Cowan (1996), the environmental crisis is in many ways a design crisis. In the IT sector, recent pushes for sustainability have focused on designing computers, applications and services to make individual attitudes and behaviours more sustainable. This work has been drawing on theories and concepts from psychology and behavioural economics (see e.g. DiSalvo et al. 2010) but also considered people’s practices, e.g. around cooking, cleaning, and moving about, which are often determined by cultural norms and conventions rather than individual decisions. This has led to the creation of a new field called persuasive technology (see Fogg 2003).

In the field of media technology, the challenge is to:

- understand people’s decision making that impact sustainability in their actual context,
- design solutions to increase motivation, awareness, skills and competences for citizens and communities to live sustainable lifestyles, and
- critically assess the impact of these hopefully more sustainable trajectories.

... Continued

For designing persuasive technology, you should consider some of the strengths of technology when used in persuasion as opposed to human actors such as:

1. persistence,
2. possible anonymity,
3. storage, access and manipulation of large amounts of historical and forecast data,
4. usage of many modalities,
5. scalability and network effects (it works well for many people, potentially even better the more people use it), and
6. ubiquity.

Projects could point to websites, applications, mobile phone apps or video games, which encourage/motivate people to change their patterns in a more sustainable direction. Different target groups could be in focus as well as different motivations and behavioural impacts. Different motivations could for example be more sustainable transportation, reduction in energy consumption or consuming less through abstinence, recycling, and deferring or shifting consumption times.

The goal could be:

- A web-side informing about sustainable tourism
- An application monitoring energy use in a household
- A mobile app to guide costumers on-spot for sustainable shopping
- An edutainment game educating school children for sustainability.

...or whatever you can imagine to create media technology for sustainability!

4 Short stories of sustainability

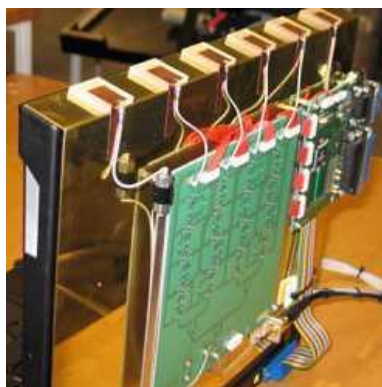
THE SHORT STORIES FOUND IN THIS SECTION ARE BASED ON INFORMATION PROVIDED IN COMPLETED QUESTIONNAIRES. SOME OF THE RESPONDENTS PROVIDING THIS INFORMATION HAD VOLUNTEERED TO PARTICIPATE IN AN INTERVIEW BUT FOR A NUMBER OF DIFFERENT REASONS, MOST OFTEN NON-COMPATIBILITY OF CALENDARS, THE INTERVIEWS NEVER TOOK PLACE; INSTEAD, WE PRESENT THE INFORMATION HERE IN A SHORT FORM.

9th Semester M.Sc. Wireless Communication Systems

In the course Multi Agent Radio Communication is included discussions of how the evolution of mobile broadband traffic - currently showing exponential growth - has implications for

- *communication network expansion strategies, hence an economic impact*
- *energy consumption of broadband communication networks, hence an environmental impact.*

This course is situated in the eco-economic area of sustainability with focus on technical and economic performance and on energy consumption of wireless broadband communication networks. Through the course, the current impact of wireless communication systems is illustrated, along with the predicted development of such systems. The course includes stakeholders, such as the individual mobile communication user, the wireless communication business and the surrounding society.



Source: www.studyguide.aau.dk/programmes/postgraduate/54210/

7th semester M.Sc. Road and Traffic

The course presents negative impacts of various modes of transport and shows how they affect road safety, but the course also includes global warming, emissions, noise pollution etc. As the main focus is on road safety the course has only limited intergenerational scope, but focuses mainly on the present.

The course includes energy, transport, safety, security practices, society and indirect economic impacts. The course is focused on three stakeholders — the road users, the authorities and the car manufactures.

3rd semester B.Sc. Architecture and Design

Teacher from 3rd semester B.Sc Architecture and Design:

In my teaching I emphasize ‘think global – act local. I demonstrate this through action research involving as stakeholders local community and professional designers, in collaboration with a group of local manufacturers in setting up a supply chain, a business model and a production of long lasting and well-designed products, made from primarily local materials, distributed locally and prepared for non-problematic disposal.

I include such aspects as sustainable production, professional ethics, cultural sustainability and sustainable radical business concepts. I furthermore make the students aware of consequences for future generations by referring to the UN forecasts for climate change.

5 Resources on Sustainability

IN CONNECTION WITH THIS PROJECT SEVERAL RESPONDENTS HAVE INDICATED THE DESIRE FOR HAVING A VIRTUAL STORE OF RESOURCES ON SUSTAINABILITY. THIS SECTION IS A VERY FIRST AND VERY MODEST ATTEMPT TO CREATE SUCH A STORE OF RESOURCES ON SUSTAINABILITY. IT IS THE HOPE OF THE RESEARCH TEAM THAT THIS INITIATIVE MAY GROW IN VOLUME AND MAY BE BENEFICIAL FOR ALL INTERESTED STAFF MEMBERS AT THE FACULTY.

MUSLI: Meeting place for University Sustainability Learning Initiatives

The objectives of MUSLI

The overall objective of MUSLI is to create a meeting place and information resource for teachers and students working with sustainability in educational programmes at Aalborg University. MUSLI's idea of sustainability in higher education is not restricted to a specific discipline or faculty, although engineering was the starting point for the formation of the group. To the contrary, the aim of MUSLI is to bring together experiences from different fields and to encourage teachers and students alike to work interdisciplinary, in the spirit of cross-fertilisation – as this is the basis for sustainability.

At the present time MUSLI is focused on the following:

- Assessment and development of curricula of different study programmes at the engineering and science Faculty
- Planning and organisation of a summer school on sustainability
- Support, in the form of seminars, workshops and other study activities, to teachers who want to integrate sustainability in their courses
- Availability of resources on the web-site of the PBL and Sustainability centre
- Development and implementation of projects across faculties and departments for both students and teachers.
- Outreach to the broader community and companies

Perspectives of MUSLI's work

Being a forum for the exchange of knowledge and the development of ideas, it is hoped that MUSLI can become an incubator for activities related to sustainability in higher education. Different members of MUSLI might come together and create project groups on a specific topic, for which they could then seek external funding. Although not actively participating in a project, all members of MUSLI could then discuss the progress of the project(s) in seminars, workshops and meetings. The discussions from MUSLI gatherings could regularly be communicated to relevant persons or organisations at Aalborg University and the outside community.

<http://www.pblee.aau.dk/musli/>

